

### ABSTRACT OF THE DISCLOSURE

The present invention is a method and apparatus for creating a narrow linewidth hybrid semiconductor laser using silicon-oxide and silicone-oxynitride based external feedback elements. These feedback elements use Bragg gratings formed by periodic variation of the refractive index with a resonant optical reflector. The laser has a narrow linewidth (in the tens of kHz range), which can be accurately tunable to facilitate locking to an ultra-stable cavity.

A semiconductor optical gain chip is soldered to a micromachined silicon bench. This semiconductor optical gain chip is coupled into a silicon-oxide/silicon-oxinitride/silicon-oxide ( $\text{SiO}_2/\text{SiON}/\text{SiO}_2$ ) waveguide terminating in an appropriate feedback element that facilitates linewidth reduction. In order to suppress the loss and scattering at the  $\text{SiO}_2/\text{SiON}/\text{SiO}_2$  interface and due to residual facet reflectance, an antireflection coating is applied. In order to achieve low loss due to mode mismatch, the waveguide modes are tailored to match the gain chip modes.